



## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

Inventor: Hyungsoo Choi

Application No.: 10/664,431

Filed: September 19, 2003

NANOSTRUCTURES INCLUDING A METAL

)  
 ) Before the Examiner  
 ) Kelly M. Stouffer  
 )  
 ) Group Art Unit 1762  
 )  
 )  
 )  
 )

**INVENTOR DECLARATION UNDER 37 CFR § 1.131**

I, the named inventor of the above-indicated patent application (the "Subject Application"), hereby declare as follows:

1. I have reviewed the Subject Application corresponding to the above-indicated Application number and the currently pending claims (the "Claims") as attached in Exhibit A, and hereby confirm that I am the inventor of the inventions set forth in the Claims. The Board of Trustees for the University of Illinois (the "University") is the sole owner of the Subject Application and all inventions claimed therein as evidenced by the assignment recorded at reel/frame number 014516/0305.
2. Invention documentation entitled: "Aligned free-standing nanowires by chemical vapor deposition" (the "Invention Report") is attached hereto in Exhibit B in a partially redacted form. Redactions are provided to remove certain dates, the name of certain individuals each of whom is not a named inventor, certain funding sources, and other confidential information. Included along with the Invention Report was a draft of a presentation entitled: "Aligned Free-Standing Nanowires by Chemical Vapor Deposition" (the "Presentation"), the first seven

Inventor Declaration Under 37 CFR 1.131

Inventors: Choi

Application No.: 10/664,431

Filed: September 19, 2003

Page 1 of 4

pages of which are attached hereto in Exhibit C (twelve subsequent pages are omitted as relates to market evaluation among other things).

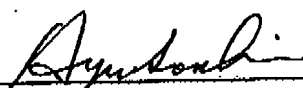
3. I conceived of the inventions defined by the Claims at least as early as December 4, 2000. A copy of the lab book page describing my observations and noted potential of the invention is attached hereto as Exhibit D.
4. A copy of micrographs showing nanowires dated February 28, 2001 is attached hereto as Exhibit E. The micrographs indicate initial experimental results of the invention.
5. A copy of the lab book page describing the conditions and results related to the February 2001 micrographs is attached hereto as Exhibit F. The lab book page indicates, on March 1, 2001, various Cu wires were documented.
6. Between March 2001 and August 2002, the experimentation was concluded and the Invention Report was prepared.
7. The Invention Report was submitted to the Research and Technology Management Office for the University on September 4, 2002.
8. Based on information and belief, between the dates of September 4, 2002 and February 2003, personnel of the Research and Technology Management Office for the University reviewed the Invention Report and contacted outside patent counsel (the "Outside Counsel") to initiate preparation of the Subject Application based on the Invention Report.
9. A copy of an email dated February 11, 2003 is attached in Exhibit G. The subject matter of the Application was referred to as the "New Invention Disclosure" and refers to "disclosure TF02130" and inventor Hyungsoo Choi in this February 11th

email. The email indicates that Scott Paynter, counsel of record, was assigned as the Outside Counsel and was involved in preparation on or about February 11, 2003.

10. Based on information and belief, a draft of the Subject Application was forwarded to the inventor on or about June 18, 2003 as evidenced by the copy of correspondence attached as Exhibit H. Between June 18, 2003 and September 19, 2003, the Subject Application was reviewed and revisions were made as warranted. Also included in Exhibit H is a copy of a fax cover sheet that forwarded revised figures with an indicated date of September 12, 2003, and correspondence from the University forwarding signature papers for the Subject Application dated September 17, 2003. On September 19, 2003, the Subject Application was filed.
11. The Invention Report summarizes problems addressed by one or more of the inventions of the Claims in section 8 on page 4.
12. Further description of inventive activity is provided in sections 9-12 on pages 4-6 of the Invention Report and in the Presentation.
13. Experiments were conducted to demonstrate the ability to grow columnar Cu nanowires at least as defined in independent Claims 1, 9, 15, 21, and 28. This demonstration indicated that the inventions as defined by the Claims are suitable for their intended purpose in the relevant technical fields. Corresponding experimental information was included in the Experimental Section of the Subject Application on pages 16-18.
14. All non-inventors that received invention information as described in the Invention Report were under an obligation not to disclose such information and/or received such information less than a year before filing the Subject Application.

15. The undersigned, being hereby warned that willful false statements and the like are punishable by a fine or imprisonment, or both (18 USC §1001), and may jeopardize the validity of the application or any patent issuing thereon, declares that all statements made of her own knowledge are true and that all statements made on information and belief are believed to be true.

Date: 4/9/07

  
\_\_\_\_\_  
Hyungsoo Choi

KD\_IM-925784\_1.DOC

## Confidential

### University of Illinois at Urbana-Champaign Invention Disclosure Form

#### General Instructions

The purpose of the disclosure form is to provide a written dated record of your invention disclosure and to provide information from which your technology can be evaluated as to its patent and commercial potential. A disclosure also is necessary to enable the University to comply with most industrial contract requirements as well as the requirement of the U.S. federal government laws and regulations as they are applied to university grants and contracts. The following information will be helpful to you when completing the attached forms.

- DO NOT MODIFY THE FORM. If questions do not apply, so indicate with "NA." Add spaces and table rows as needed.
- An invention disclosure should be completed when something new and useful has been conceived or developed, or when unusual, unexpected or unobvious research results have been achieved and can be utilized. In accordance with the University of Illinois General Rules Concerning University Organization and Procedure, Article III (Section 7a),
- *All intellectual property in which the University has an ownership interest under the provisions of this policy and that has the potential to be brought into practical use for public benefit or for which disclosure is required by law shall be reported promptly in writing by the creator(s) to the designated campus officer through the appropriate unit executive officer(s) using the disclosure form provided by the campus.*
- The purpose of the disclosure is to provide detailed information about the technology, to cite any relevant sponsorship and publication information that will enable the Office of Technology Management (OTM) and outside counsel to determine if the technology is patentable, and to identify possible opportunities for licensing and commercializing the technology.
- Identifying all individuals who contributed to or worked on the technology is very important. Inventorship is defined by U.S. patent laws and is usually determined at the time a patent application is filed. When completing the disclosure form, please list all individuals who contributed to the conception or development of the technology.
- After the OTM receives the completed signed disclosure, the OTM will review it and contact the inventors shortly thereafter to arrange a meeting to discuss the disclosure and the technology.
- If additional space is needed to complete this form, please add or provide information in the form of an attachment.

For advice on completing the disclosure form or for additional information, contact the OTM. Return the *completed and signed* disclosure along with supporting documentation to:

**Office of Technology Management**  
University of Illinois at Urbana-Champaign  
319 Ceramics Building (MC-243)  
105 South Goodwin Avenue • Urbana, IL 61801  
(217) 333-7862 ph • (217) 265-5530 fx  
otm@uiuc.edu

## Confidential Invention Disclosure

University of Illinois at Urbana-Champaign

1. TITLE OF INVENTION (*non-enabling, yet descriptive and concise*):

Aligned free-standing nanowires by chemical vapor deposition

## 2. NON-CONFIDENTIAL DESCRIPTION

*Provide a brief, non-enabling description of the invention and identify keywords that describe your invention.*

This invention discloses the fabrication of aligned nanometer-scale wires by chemical vapor deposition at low temperatures. The processing conditions are adjusted so as to promote the growth of wires instead of films. The growth process requires neither catalysts nor pore channels on the substrate.

## 3. INVENTOR(S):

Inventorship is determined by criteria specified in U.S. patent law. A legal inventor is generally someone who has conceived or contributed to an essential part of the invention, either independently or jointly with others during the development or conception of the technology or the technology's reduction to practice. Final inventorship is determined by patent counsel at the time the patent application is filed.

Please list all those who worked on the technology and describe their contribution to the invention. Please place an asterisk (\*) next to the name of the corresponding inventor (the inventor to whom correspondence will be sent). If any person holds a joint appointment with any other university, a company or governmental agency, or the like, please note that fact.

## INVENTOR:

Name:	Hyungsoo Choi		
Dept/Unit	Department of Electrical and Computer Engineering		
Affiliations:	College of Engineering		
Address-Work:	155 Everitt Laboratory		
	1406 West Green Street, Urbana, IL 61801		
Phone:	217-244-6345	Fax:	217-265-0957
	Email: hyungsoo@uiuc.edu		
Address-Home:	1712 Brighton Court		
	Champaign, IL 61822		
Citizenship:	Korea		
Contribution:	Choi has been developing new metal/metal oxide precursors, such as copper, aluminum, cobalt, nickel and iron, for chemical vapor deposition processes (CVD) by synthesizing new organometallic complexes and investigating their chemical and physical properties as well as deposition behaviors. The subject technique of the present invention was developed by Choi as she was investigating the deposition behavior of the copper CVD precursors developed by her previously. Compared to the conventional copper CVD precursors, these copper precursors exhibited unusually high thermal stability. Further, the deposited copper films exhibited columnar structures. Noticing this Choi studied the film deposition behaviors of the precursors focusing on the columnar growth of the films and the deposition conditions enhancing the columnar growth. As a result, vertically aligned copper nanowires were grown on Si from the precursor under CVD conditions at low substrate temperatures (<300°C). The nanowires were deposited not only on Si but also other substrate surfaces including conducting and non-conducting surfaces.		

## 4. DATES OF CONCEPTION, REDUCTION TO PRACTICE, AND PUBLIC DISCLOSURE

Conception according to U.S. patent law involves the formulation in the mind of the inventor(s). It is the point when the means by which the technology can be produced is perceived or realized.

Reduction to practice can be accomplished two different ways. Actual reduction to practice is a physical embodiment of the invention for its intended use. Constructive reduction to practice is reasonable theoretical proof that the invention will work, which is described in writing.

Public disclosure is a sale or an oral, written, or electronic disclosure of the invention to a person outside the research team, that would enable another person skilled in the field to practice the invention or repeat its development.

Please provide copies of any publication(s) or abstract(s), oral or written, as well as any proposed publications which mention or describe the invention in whole or in part. Accurate data is essential, as public disclosures may affect patent rights.

		Date
Date of conception of invention: Is this date documented in writing? If so, where?	The idea of growing Cu wires by CVD was conceived by Choi while depositing Cu films using the Cu precursors invented by her. Due to the unusually high thermal stability of the precursors, the films exhibited columnar growth.	12/4/00
Date of first reduction to practice:	Growth of Cu wires was observed as varying the precursor and deposition conditions such as precursor feed rate and deposition temperature.	3/1/01
Dates of disclosure (oral, written, or electronic) and names of persons or companies to whom disclosed under a confidentiality agreement:	Recently, on different occasions between July 15 and August 10, the pictures of the NiO nano-soccerballs were shown to Professors Kevin Kim, Ilesanmi Adesida, Gary Eden, and Dr. Ju Gao of ECE, Professor Moonsub Shim of MatSE, and Professor Min-Feng Yu of M&IE, but without revealing how the nanowires were obtained. Choi described the present invention to Mr. Roger VanHoy of the TMO (Technology Management Office) on August 15, 2002 at a meeting in his office in the presence of Professor Kim. At this meeting Choi informed Mr. VanHoy that a proposal seeking funds from the UIUC Campus Research Board would be submitted on August 19. Choi was then advised by Mr. VanHoy to go ahead and submit the proposal but do so with a cover letter saying that the proposed work should not be disclosed to anybody without a written consent of the TMO. These instructions have since then been followed in the submission of the proposal to the Research Board.	
Dates of disclosure (oral, written, or electronic) and names of persons or companies to whom disclosed without a confidentiality agreement:		
Date first publication was submitted and date published (electronic, print, thesis or other media)		
If unpublished and undisclosed, provide the anticipated disclosure date and any submissions already made for potential publication		

**5. PRIOR ART**

*Cite known publications and patents of others believed by you to disclose ideas most closely related to the invention (attach copies, if available):*

To the best of my knowledge nobody has ever produced vertically aligned nanowires, from a precursor by CVD without templates, catalysts or lithographic processes, described in this invention disclosure.

**6. SPONSORSHIP**

*Identify all grants, contracts, and other sources of funds contributing to or possibly contributing to the conception and/or development of the invention. Please note that accurate and complete sponsorship information is required to fulfill UIUC obligations under research grants and contracts.*

Agency or Sponsor	Grant/Contract/Other Number	UFAS No.

**7. FUTURE FUNDING**

*If work on the invention is to be continued, indicate known or probable sources of funding and the nature of the work yet to be performed.*

The inventor would like to further investigate and extend the present work using external support. To secure such support additional data collection will be required. To facilitate this the inventor recently submitted a proposal to the Campus Research Board requesting for a seed money. Proposals seeking money from external funding agencies will also be prepared and submitted. However, prior to taking these actions the inventor would like to have the intellectual property right of the present invention properly protected.

**8. GENERAL SUMMARY OF THE INVENTION**

*Please provide a brief summary of the invention, addressing: What is the purpose of the invention? Is it a new product, process, or composition of matter? Is it a new use for or improvement to an existing product, process or composition of matter?*

This invention relates to vertically aligned metal/metal oxide nanowires fabricated on substrate by chemical vapor deposition at temperatures in the range of 200 – 400 °C. The substrate requires neither pores nor catalysts on the surfaces to grow the nanowires having a diameter in the range of 1 – 500 nm. The substrates include various metallic, metal oxide, and plastic surfaces.

**9. PRIOR METHODS OR APPARATUS**

*How long has the problem addressed by this technology existed? Provide a full and complete description of the closest known prior methods or apparatus and any disadvantages or problems of each that are solved by the present invention. Attach any materials, such as publications, advertisements, or patents of others, that you have or that are reasonably available to you concerning the known prior methods or apparatus.*

Although there have been several processes reported for the synthesis of semiconductor nanowires, a few methods have been developed for preparing metal nanowires.

One of the methods to fabricate nanowires utilizes microlithographic process followed by chemical vapor deposition. This method has limitations since it requires generation of an array of closely spaced nanowires using conventional microlithographic techniques which has limitations in the pattern generation on masks in terms of size and tolerance as well as in the CVD processing to deposit the material forming the wire.

Another method of nanowire or rod fabrication involves filling arrays of nanochannels or pores in a substrate with a material of interest by chemical or electrochemical processes using precursors. With this method, it is difficult to



continuously fill pores having a relatively long length and small diameter with a desired material having high density. To fill the pores, high pressure and high temperature injection of molten metals has also been used, however, it would not be suitable to fabricate small pores with long length since it would require extremely high pressure along with high temperature. Although there has been an effort to lower the processing pressure by modifying the composition or surface property of the substrate pores, the process would be limited only to the low melting metals.

These methods, however, would not produce free-standing metal nanowires without etching off the templates. The step-edge decoration method was reported to grow free-standing nanowires, where Mo oxide wires were electrodeposited at step edges on a graphite surface and reduced in  $H_2$  to produce metal. This method is not applicable to produce noble metals, including silver, platinum and copper which do not nucleate along step edges on graphite to form nanowires. Another method reported is to synthesize Au, Ag and Pt nanowires using reducing and sacrificing templates. The nanowires prepared by this method are polycrystalline. Neither step-edge decoration nor sacrificing template methods are capable of producing vertically aligned free-standing metal nanowires.

#### 10. DISADVANTAGES OR LIMITATIONS

*Indicate any disadvantages or limitations of your invention. Explain how they might be overcome.*

#### 11. BEST MODEL

*Give a complete detailed description of the best model for practicing your invention. Provide data or other evidence of the feasibility or operability of the invention. Attach any visual material that may be available, such as: sketches, graphs, drawings or photographs. Indicate any alternate embodiments, procedures or methods of construction for the invention.*

The present invention describes the nanowires fabricated by chemical vapor deposition of metal precursors at low temperatures. The nanowires are vertically aligned on substrate having smooth surface. The process requires neither catalysts nor indented pores/channels on the substrate. The copper precursor,  $Cu(ethylacetoacetate)L_2$ , where  $L$  = trialkyl phosphite, was evaporated at around  $100^\circ C$  and thermally decomposed to deposit copper nanowires on Si substrates at a temperature range of  $200 - 400^\circ C$  under  $0.1 - 1.0$  torr with or without using carrier gas such as argon during the CVD process. No reducing agent such as hydrogen was used to produce metal nanowires. The nanowires were grown not only on Si but also on various substrate surfaces including conducting and dielectric surfaces such as  $SiO_2$ , TiN and metals under proper processing conditions. Figure 1 shows an SEM image of the copper nanowires deposited on a brass surface at a substrate temperature of  $250^\circ C$ . The copper nanowires were highly pure (XPS) and single crystalline (TEM). Figure 3 shows a TEM image of the copper nanowires. were single crystalline. When the CVD process was carried out in the presence of oxygen, copper oxide nanowires would be grown.

#### 12. STAGE OF DEVELOPMENT

*Describe the development status (concept only, laboratory tested, prototype, etc.). Indicate what further development may be necessary.*

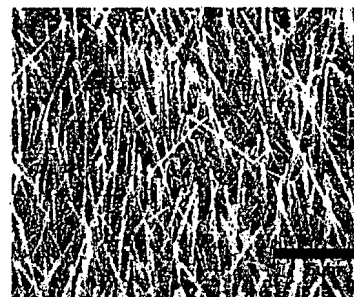


Figure 1. An SEM image of Cu nanowires grown on brass.

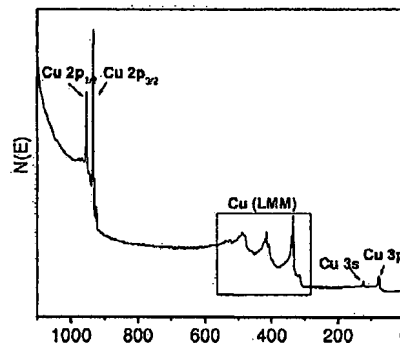


Figure 2. An XPS spectrum of Cu nanowires grown at  $250^\circ C$ .

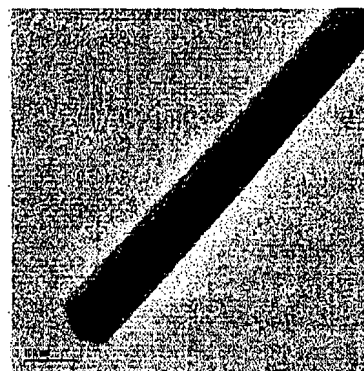


Figure 3. A TEM image of a Cu nanowire.

The present invention was tested in the laboratory. The physical properties and application aspects of Cu nanowires are under investigation.

### 13. POTENTIAL LICENSEES

List any potential licensees or end users that may be interested in this technology.

### 14. THE DISCLOSURE SHOULD BE SIGNED AND DATED BY THE INVENTOR(S), AND THEN READ AND SIGNED BY A NON-INVENTOR WITNESS.

I (We) hereby agree to assign all right, title and interest to this invention to UI and agree to execute all documents as requested, assigning to UI our rights in any patent application filed on this invention, and to cooperate with the OTM in the protection of this invention. UI will share any royalty income derived from the invention with the inventor(s) according to the General Rules, Article III, Section 8.

Inventor(s) Signature	Date	Witness

Unit Executive Officer(s) Signature	Date	Printed Name & Unit

**DISTRIBUTION** Prepare and distribute copies of the completed Invention Disclosure Form as follows:

- ☐ copy for each Inventor's file
- ☐ copy to each Unit Executive Officer
- ☐ original and 2 copies to the Office of Technology Management, 319 Ceramics Building, 105 South Goodwin Avenue, Urbana, IL 61801 (MC-243)

#### ✓ CHECKLIST FOR COMPLETION OF INVENTION DISCLOSURE FORM:

- ☐ Attach supplemental materials, such as copies of the inventor's oral or written publications
- ☐ Attach copies of publications or patents closely related to the invention enclosed
- ☐ Provide grant or contract numbers along with UFAS account numbers
- ☐ Obtain signatures of all inventors, the Unit Executive Officers, and witnesses
- ☐ Enclose 2 copies and the original disclosure form for the OTM, and distribute other copies as specified



Office of Technology Management

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

# **Aligned Free-Standing Nanowires by Chemical Vapor Deposition**

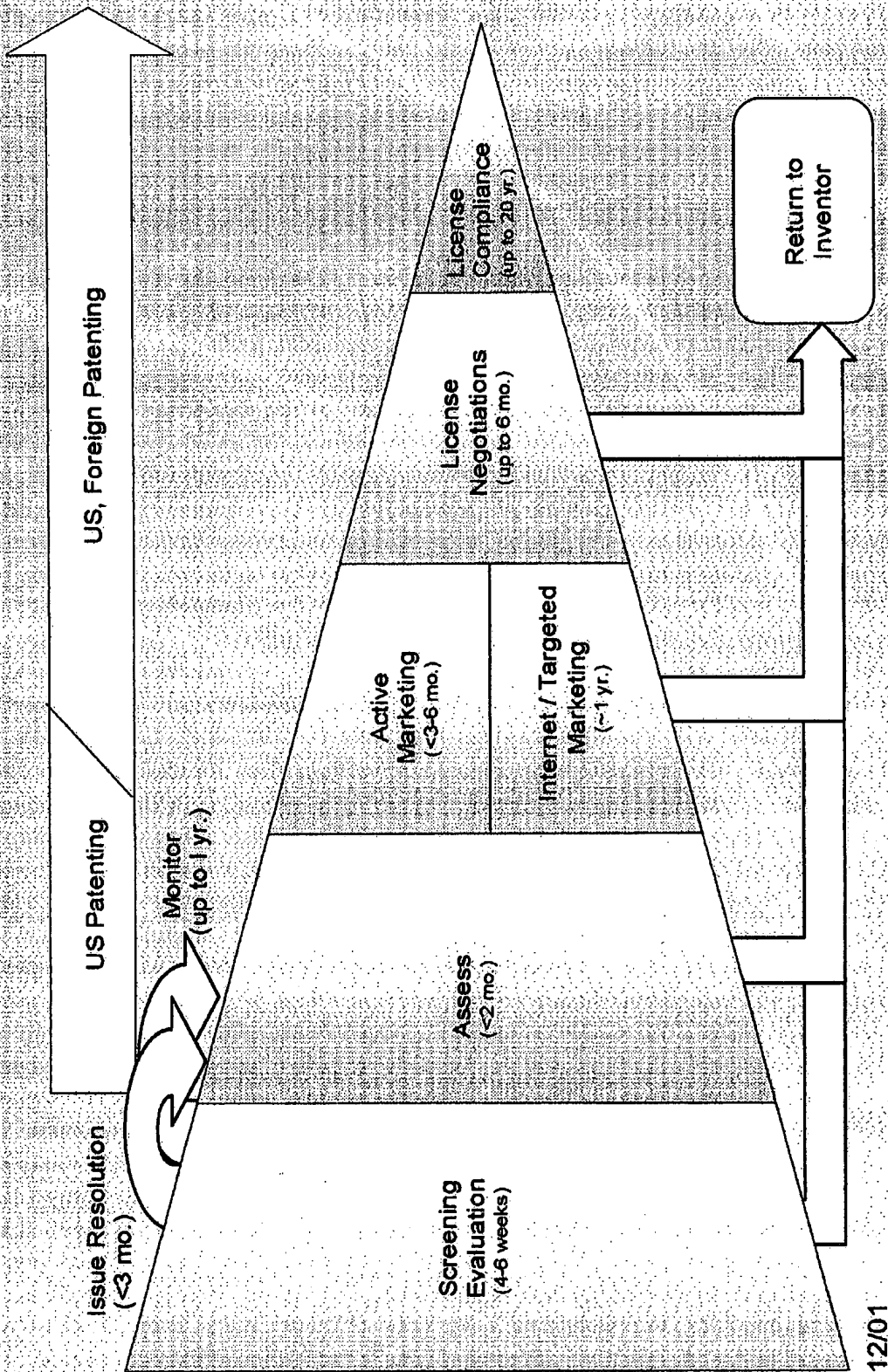
**OTM Tech Number: TF02130  
Submitted to OTM on September 4<sup>th</sup> 2002**

**By  
Hyungsoo Choi**

**OTM Confidential and Proprietary**



# The Technology Life-Cycle





# Screening Evaluation Process

- **Technology Overview**
  - Non-enabling Description
  - Features and Benefits
  - Applications
- **Intellectual Property Analysis**
  - Potential Prior Art
  - Patentability
  - Overall IP Strength
- **Business Issues**
  - Market Analysis
    - Size, structure, potential licensees, and potential competition
  - Market Potential
  - Commercialization Issues
    - Level of development, ease of implementation, and timing





## **Technology Overview: Non-enabling Description**

**The invention is a novel technique for fabricating vertically aligned, free-standing metal/metal oxide nanowires (*Copper here*) on a substrate by chemical vapor deposition, at low temperatures in the range of 200-400 deg. C**

**Important features of this technology are:**

- Substrate requires neither pores nor catalysts on surfaces to grow**
- Substrate includes various metallic/metal oxide/plastic surfaces**
- Nanowires grown have diameter in the range of 1-500 nm**



## Technology Overview: (Cont'd)

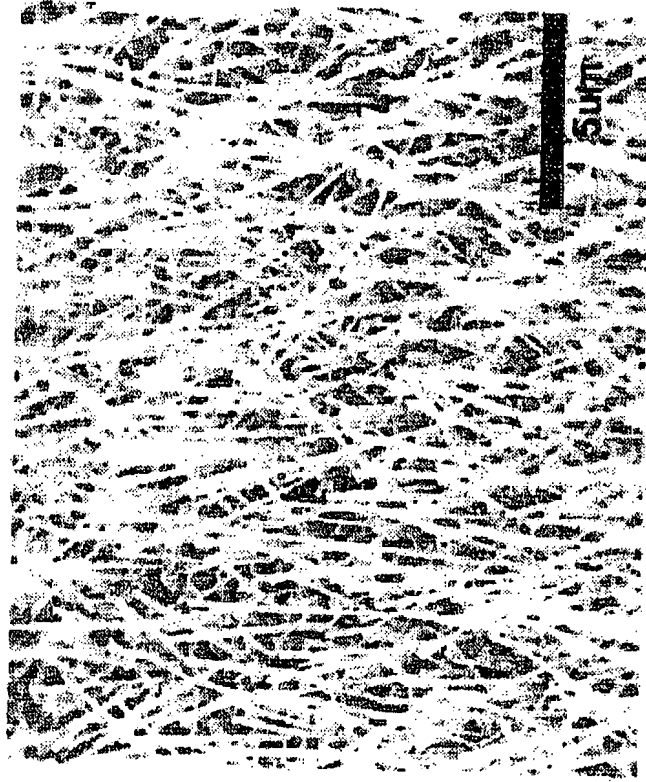


Figure 1. An SEM image of Cu nanowires grown on brass.

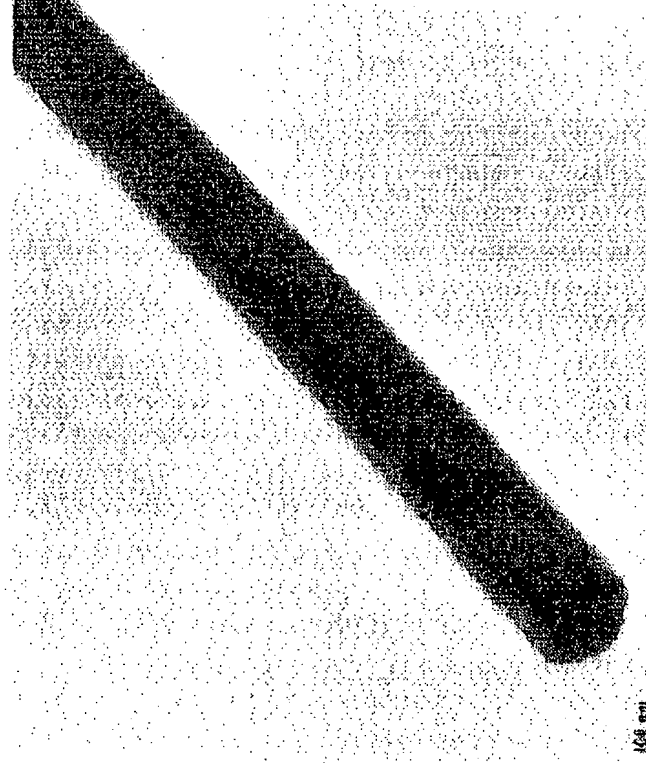


Figure 3. A TEM image of a Cu nanowire.



# Technology Overview: Features & Benefits

## Features

- Nanowires growth process has no catalysts/pore channels on the substrate

## Benefits

- Cheaper, greater flexibility
- Allows 'controlled' growth of nanowires
- Varying length and radius of curvature of nanowires
- Allows nanowires growth on both conducting and non-conducting substrates
- Flexibility and potential for new applications





# Intellectual Property Analysis: Potential Prior Art

## • Prior Art Databases Used:

- OneSource
- Delphion

## • Search Terms Used:

- Aligned Nanowires, substrates, CVD etc.
- Various combinations used, such as ((nanowires AND aligned AND copper, nanowires AND CVD AND aligned)) etc.

## • Relevant Patents, Patent Activity, etc.:

- No references or patents were found that describe the technology as such
- Nobody has ever produced free standing copper nanowires by CVD technique



## **Technology Overview: Applications**

The copper nanowires produced through this technique can be used for:

- Field emission flat panel displays (FEDs)
- Electron emitting film display/Microelectronic Applications
- Next generation of monitor/television screen display development
- Development of Advanced nanotube composites
- Microwave Applications
- Other novel, practical research applications

12/4/00

from 12-1 ~ 12/3

Synthesis of  $(\text{Etac})\text{Cu}(\text{TMP})_2$  &  $(\text{Etac})\text{Cu}(\text{TEP})_2$

both 140°C DM MP  
90-100°C vapor & MP  
MP 107  
MP & MP (MP 107)

decompose at 148°C  
at bath 170°C  
distil off (bp 150°C)  
with decompose  
110-120°C TEP 170°C  
MP 140°C 170°C

$(\text{Etac})\text{Cu}(\text{TMP})$   
 $(\text{Etac})\text{Cu}(\text{TEP})$

→ Ref. MP MP (TMP) & TEP  
MP  $\text{Cu}(\text{Etac})_2$  MP

details  
of synthesis

$(\text{Etac})\text{Cu}(\text{VTMS})$

100°C DM MP

0.03 MP

very oxygen sensitive

130°C bath MP

60-70°C MP MP

vap of pressure  
higher

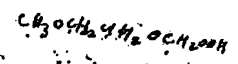
NMR

↑  
pure

$(\text{Etac})\text{Cu}(\text{VTMS})$

but  
stabilized than  $(\text{Etac})\text{Cu}(\text{VTMS})$   
higher boiling

coloured growth  
(brownish green for air)  
w/ delectra

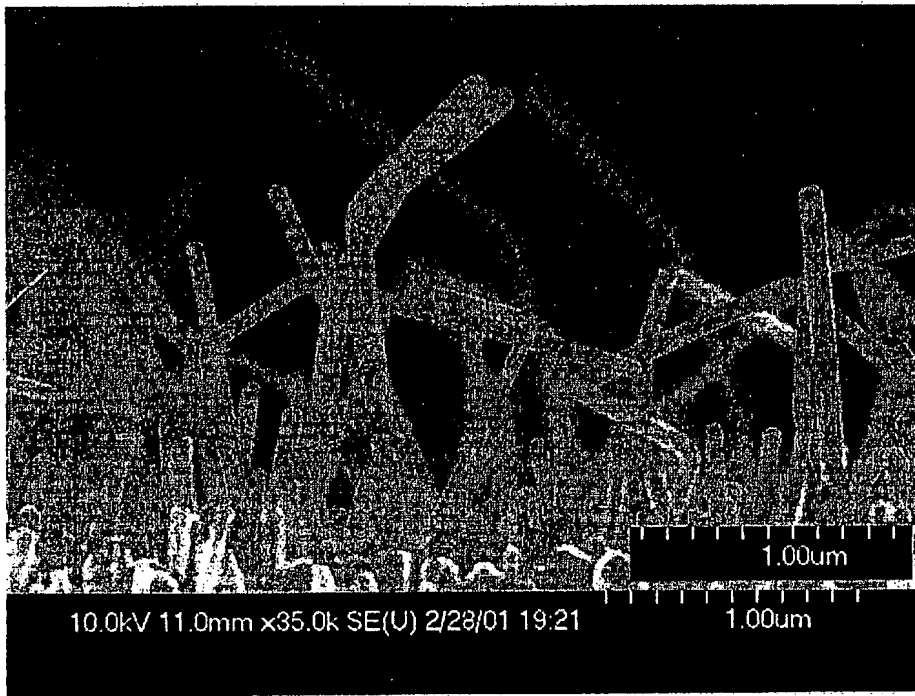


95%

$\text{Li}(\text{OR})_4 + \text{H}_2\text{O}$

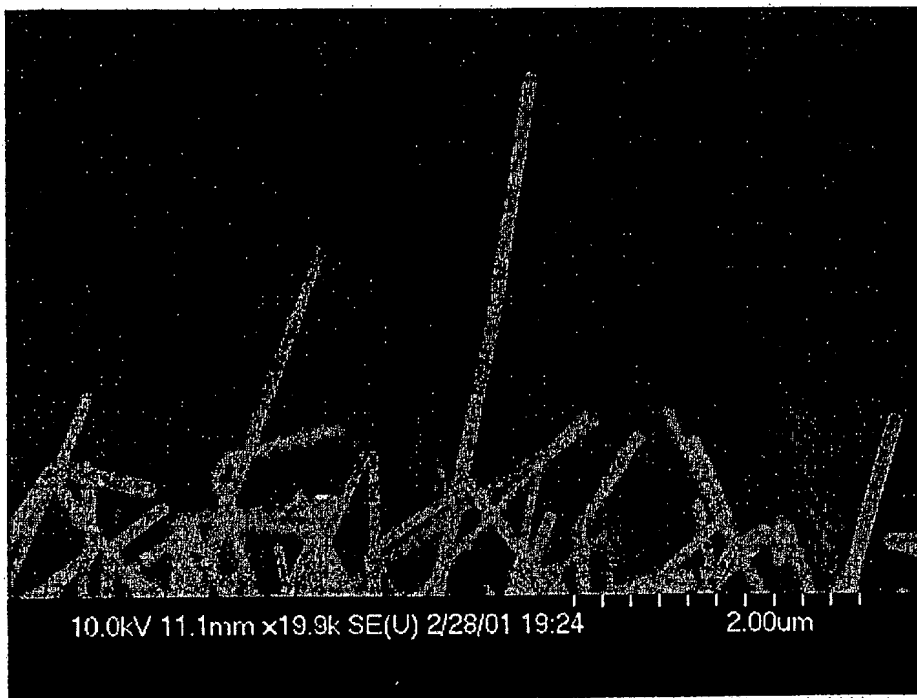
has

1)  $2 \cdot (\text{HOCH}_2\text{CH}_2\text{CH}_2\text{OH})$



10.0kV 11.0mm x35.0k SE(U) 2/28/01 19:21

1.00um



3/1/01

Sample needs to do experiments using  $\text{Cu}(\text{BTAC})(\text{VTMS})$   
based on the results on  $\text{Cu}(\text{BTAC})(\text{PMP})_2$ ,  $\text{Cu}(\text{BTAC})(\text{TBP})_2$   
 $\text{Cu}(\text{BTAC})(\text{TBP})_2$

since  $\text{Cu}(\text{BTAC})\text{L}$  are more stable than  
 $\text{Cu}(\text{BTAC})\text{L}$ , growth temp was higher  
& columnar growth was observed  
(long rods were grown)

sticking coefficient is important.

$\text{Cu}(\text{BTAC})(\text{TBP})_2$  was  
good for nanowire fabrication  
→ tested the growth using different precursors by varying  
the rxn conditions. (2/29/01)

15

+180°

Fiel

74

66

4009

74

2

**Cox, Stephanie**

---

**From:** Paynter, Scott  
**Sent:** Tuesday, February 11, 2003 1:30 PM  
**To:** Cox, Stephanie  
**Subject:** FW: New Invention Disclosure; TF02130

Attached is a new patent disclosure from Illinois (UIUC) client number 22010. Please make two copies of each attachment ( 1 a working copy and 1 original to mount) and mount this message, too. Get a new matter number for this patent application and create a folder for it. We need to tell billing the reference number from UIUC for inclusion in the bill

Thanks

Scott

-----Original Message-----

**From:** Willis S Colburn [mailto:wcolburn@ad.uiuc.edu]  
**Sent:** Tuesday, February 11, 2003 11:10 AM  
**To:** Paynter, Scott  
**Cc:** pddavis@uiuc.edu; r-vanhoy@uiuc.edu  
**Subject:** New Invention Disclosure

Scott,

Here is the invention disclosure that I mentioned the other day along with a set of power point slides summarizing our findings from an initial screening process. Our file number for this disclosure is TF02130, and the inventor is Hyungsoo Choi. Let me know if you want me to set up a telecon with the inventor. I will see if she can provide us with publications and references that might be relevant to this technology.

I will need an estimate of the cost to prepare and file a non-provisional US patent application, and once I have received that from you, we will prepare a Letter of Referral (LOR) to send to you.

Best regards,  
Bill

Willis S. Colburn  
Patent Coordinator  
Office of Technology Management  
University of Illinois  
319 Ceramics Building, MC-243  
105 South Goodwin Avenue  
Urbana, IL 61801

Phone: 217-265-6217  
Fax: 217-265-5530  
Email: [wcolburn@uiuc.edu](mailto:wcolburn@uiuc.edu)

2/11/2003

# WOODARD, EMHARDT, MORIARTY, McNETT & HENRY LLP

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June 18, 2003

Hyungsoo Choi  
Department of Electrical and Computer Engineering  
University of Illinois  
155 Everitt Laboratory  
1406 West Green Street  
Urbana, IL 61801

RE: New Patent Application  
Inventor: H. Choi  
Title: NANOSTRUCTURES INCLUDING A METAL  
Our Ref: 22010-199  
Your Ref.: TF02130

Dear Soo:

Please review the attached draft of the patent application for the above-indicated invention disclosure. A few items to consider are outlined below. If any changes should be made, please make them directly on the enclosed copy and return them to us so that we may incorporate your changes into the original to be filed with the U. S. Patent and Trademark Office. Also enclosed are signature papers consisting of: (1) an Assignment and (2) a Declaration and Power of Attorney that should be signed and dated where indicated once the application is approved for filing by you. Once executed, these papers should be returned to us for filing with the application.

## Review of the Description and Drawings:

Please review the application for completeness and accuracy. Does the application disclose all the details necessary for any person skilled in the field to be able to make and use the invention? Is the best mode of carrying out the invention adequately described?

Feel free to point out any other details or advantages of which you are aware of that are not described or not adequately described. In particular, what else should be discussed with respect to your new concept? Can any additional alternative design features be included in the application?



Review of the Claims:

Note that each numbered claim appearing after "What is claimed is" on page 18 of the application provides a separate definition of the invention, and hence, each claim will afford a different scope of protection if granted. Some claims are more specific than others. I have sought to cover the invention in its broader aspects and its narrow aspects by drafting a number of claims of varying scope. In general, the more detail a claim has, the more narrow the protection afforded by the claim.

When reading the claims, please ensure that at least the broader claims cover the various ways in which the invention can be practiced. Consider whether any of the independent claims (claims 1, 9, 15, 21, 28, and 35) appear to include any limitations which are unnecessary to the preferred embodiment of the invention. If a claim recites an element not present in a particular variation or embodiment of the invention, that claim will probably not cover that embodiment. If none of the claims cover a particular variation of the invention, please let me know. If so, we will likely need to add further claims.

Inventorship:

It is my present understanding that there is only one inventor of the inventions defined by the claims of the application. We would like to confirm this understanding with an explanation of how inventorship is determined under the patent laws.

The determination of inventorship turns on who conceived of the invention. Inventive "conception" is described as the formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice. Thus, the test for conception is whether the inventor had an idea that was definite and permanent enough that one skilled in the art could understand the invention. Conception is generally more than a lofty goal or research plan, but does not require the inventor to know that the invention will work as intended.

Generally speaking, there are two circumstances resulting in the naming of multiple inventors. One possibility is that you work jointly with the other inventors as part of a design team with some or all of the other inventors, and that group is jointly responsible for conception of the invention such that any individual contributions are merged into the whole and are not separately identifiable. The other possibility is a specific contribution directed to one or more features of the conceived invention. For example, one inventor may have been asked by one or more of the other inventors to direct their effort to one particular area of the design or one particular component. If this second possibility accurately describes the situation, please indicate the nature of each inventor's contribution to the subject invention. If the first possibility accurately describes the role of one or more inventors, please let me know that as well and we

Hyungsoo Choi

June 18, 2003

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will proceed accordingly. Also, a mixture of these circumstances is possible when multiple inventive concepts exist.

Inventorship is analyzed claim-by-claim. In other words, inventorship may differ from one claim to the next. For a given application, it is necessary to name all persons that invented one or more of the claims presented in the application. Please let me know if you believe, in view of the above explanation, that other inventors might need to be named. Generally, it is easier to add inventors before filing an application.

Inventor Duties:

When executing a patent application, an inventor assumes certain obligations and makes certain important representations. A patent application must be filed in the United States within one year after the first public disclosure or use, or offering for sale of the invention. By signing the Declaration and Power of Attorney for an application, an inventor is representing that this requirement is being met. Also, every inventor who files a patent application has a duty to disclose all prior patents, publications and other information of which he or she is aware that may be material to patentability of the application. The obligation to disclose prior art is a continuing duty throughout the prosecution of the patent application. It is also necessary to disclose in the patent application details of the invention that would enable a person of ordinary skill in the art to make and use the claimed invention without undue experimentation, and to disclose the best version of the invention known to the inventor at the time the patent application is filed. Failure to meet any of the above requirements may have the effect of invalidating any patent that might be obtained on the invention.

Sincerely,



L. Scott Paynter

Enclosures

Cc: Bill Colburn (with enclosures)

022010-000199.LSP.225770

# WOODARD, EMHARDT, MORIARTY, MCNETT & HENRY LLP

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## FAX COVER SHEET

**Date:** Friday, September 12, 2003

**Number of Pages:** Cover sheet plus 7 page(s)

**From:** L. Scott Paynter ([spaynter@uspatent.com](mailto:spaynter@uspatent.com))

**Our Reference #:** 22010-178

**Special Remarks:** Please see attached drawings from TF02130

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UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN

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September 17, 2003

Scott Paynter  
Woodard, Emhardt, Naughton, Moriarty & McNett  
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111 Monument Circle, Suite 3700  
Indianapolis, IN 46204-5137

**RECEIVED**  
**SEP 19 2003**  
Woodard, Emhardt, Moriarty,  
McNett & Henry LLP

RE: U.S. Patent Application titled  
"Nanostructures Including A Metal"  
Your Reference No. 22010-199; Our File TF02130

Dear Mr. Paynter:

Enclosed please find the executed Assignments and Declarations for the above file.

Respectfully,

Pamela Davis  
Legal Secretary

Enclosures